Introduction

Background

The Northeast Fisheries Science Center (NEFSC) initiated a fisheries acoustics survey program in 1998 to provide fisheries-independent estimates of absolute and relative abundances of pelagic fish stocks. The program was developed in response to a FY1998 Congressional appropriation, which supported the development of hydroacoustic surveys to provide additional input into stock assessments of Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*). Increased interest was generated in part because of a recent expansion of the Atlantic herring fishery to include joint ventures. Although bottom trawl surveys have successfully been used to index the trends in abundance of these stocks, they do not sample the water column in which these pelagic species live. Hydroacoustic data could be a valuable addition to traditional catch-at-age data for pelagic stocks, particularly for those populations in which landings data are sparse.

Earlier hydroacoustic research was conducted during 1995-97 field studies under the auspices of the NOAA Coastal Ocean Program. During 1995-97, the NEFSC hydroacoustic, midwater trawling, and underwater video capabilities were first developed and used to characterize the distribution and relative abundance of Atlantic mackerel and other potential pelagic predators of larval fish on Georges Bank. The 1998-2001 Atlantic Herring Hydroacoustic Surveys were the NEFSC's first efforts to implement an annual systematic monitoring survey using fisheries acoustic methodology. This document provides a summary of the operational and analytical procedures used during the NEFSC's 1998-2001 Atlantic Herring Hydroacoustic Surveys.

Program Resources

There are four positions associated with this program: one fishery biologist with advanced background in acoustical oceanography, one fishery biologist with advanced background in fisheries ecology with hydroacoustic applications, one contract technician with developing expertise in data post-processing, and one fishery biologist with advanced background in stock assessment. The first three individuals are members of the Ecosystems Surveys Branch; the third is a member of the Population Dynamics Branch, with additional assessment responsibilities within that branch. Two fisheries biologists are funded from Center base funds (one in Ecosystems Surveys and one in Population Dynamics); the third is funded from the annual appropriation. The technician is funded from the annual appropriation.

Funding from the appropriation after FY1998 has been fixed at $200,000. About 61% of that funding supports most of the salary and associated overhead for one permanent fishery biologist. Costs of a six-week autumn survey of Atlantic herring in the Gulf of Maine include staff overtime (12% of budget) and field equipment (5%). Shore-based costs include computer hardware for data post-processing and archiving (2%), software licenses (4%), and travel to scientific meetings (3%). Only five months of salary for a contract technician (13%) can be supported under this funding level, down from twelve months since the start of the program. This is due to increased permanent labor costs but a fixed appropriation over time.

Smaller additional funding sources in recent years include an Office of Naval Research (ONR) grant and ad hoc funding within the Center. ONR has provided 15% of the salary support for one permanent fishery biologist as part of a separate research grant. Last fiscal year, the Center paid for staff overtime for an additional four-week spring survey season to develop hydroacoustic capability for surveying Atlantic herring, mackerel, and other pelagic species in the Mid-Atlantic Bight. It also provided support for a major software acquisition (SonarData). In general, however, the program has been expected to function from the appropriation.

Historical Background on the Gulf of Maine – Georges Bank Herring Complex

The Atlantic herring (*Clupea harengus*) resource in the Northwest Atlantic has been an important source of food and commerce for nearly four centuries (Anthony and Waring 1980). Simple weir fisheries with relatively low landings began in the 1600s in both the United States and Canada, but evolved into much larger operations with increased landings. The most important early fishery for herring in the United States developed in the late 1800s with the building of numerous sardine canning plants, resulting in annual landings eventually ranging from 60,000 mt to 100,000 mt by the early to mid 1900s (Anthony and Waring 1980). An important weir fishery developed in New Brunswick during the 1950s, which also provided herring for canning operations in the region. Both the US and Canadian fisheries initially focused on juvenile fish, and fisheries for adults only developed when the abundance of juveniles (available to fixed gear) declined in the early 1960s (Anthony and Waring 1980).

In the early 1960s, Atlantic herring on Georges Bank became the focus of a major fishery by gill net vessels from the former Soviet Union (Hennemuth and Rockwell 1987). By the mid 1960s, distant water herring fisheries had developed in the Gulf of St Lawrence, on the Scotian Shelf, on Georges Bank, and on Jeffreys Ledge increasing fishing pressure (Anthony and Waring 1980). The resulted in the landings of herring from the Gulf of St Lawrence to Georges Bank to peak over 900,000 mt in 1968, and declined steadily thereafter (Figure 1.3.1).

The Georges Bank herring fishery (combined Nantucket Shoals and Georges Bank regions) began in 1961 and increased rapidly to a peak of 373,000 mt in 1968 (Figure 1.3.1). During the early 1970s, landings steadily declined and in 1977 the herring fishery on Georges Bank collapsed with low landings and abundance (Figure 1.3.1) (Anthony and Waring 1980; Tupper et al. 1998). During the same period, landings in the Gulf of Maine fishery ranged from 35,000 to 82,000 mt.

Stock assessments prepared by the International Commission for Northwest Atlantic Fisheries (ICNAF) for Georges Bank herring (combined Nantucket Shoals and Georges Bank) began in the late 1960s, with annual total allowable catch quotas (TAC) being established in 1972. Annual assessments were conducted using virtual population analysis (VPA), and results from these assessments revealed that the Georges Bank component peaked in abundance in 1967 and rapidly declined thereafter (Anthony and Waring 1980). These findings were confirmed by larval herring surveys during the 1970s and 1980s. A general decline in larval abundance in the region was noted during 1975-1978 and the complete absence of herring larvae in the Georges Bank-Nantucket Shoals region during 1979-1984 (Lough et al. 1985; Smith and Morse 1993).

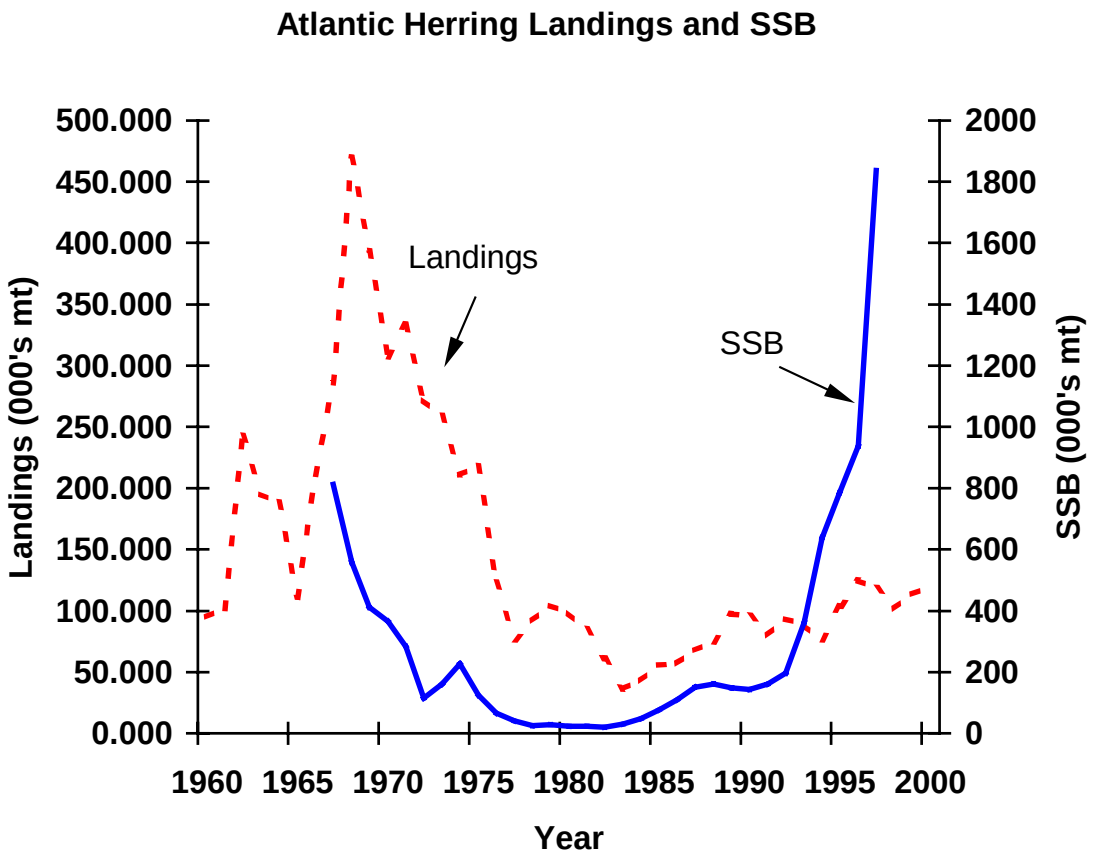

Figure 1.3.1. The Georges Bank herring fishery (combined Nantucket Shoals and Georges Bank region) began in 1961 and increased rapidly to a peak of 373,000 mt in 1968. During the early 1970s, landings steadily declined and in 1977 the herring fishery on Georges Bank collapsed with low landings and abundance. The Atlantic herring populations in the Georges Bank region have recovered to historic high abundance by the end of the 1990s.

Presently pelagic fishes such as Atlantic herring and mackerel (*Scomber scombrus*) have recovered to historic high abundances (Clark 1998). Atlantic herring have recovered to pre1960s biomass and abundance and are now becoming the subject of renewed interest by fleets from the US and Canada (Clark 1998; NEFSC 1998). During the recent 1999 Spring NEFSC Bottom Trawl Survey, herring were caught in 47% of the standardized tows and represented one of the top five species in terms of abundance and biomass (NEFSC 1999). The herring recovery is also documented by the abundance of spawning fish and larvae in historically important areas of Nantucket Shoals (Great South Channel area), Georges Bank, and along the coast of Maine ((Zinkevich 1967; Stevenson 1989; Stephenson and Kornfield 1990; Smith and Morse 1993).

References

Anthony, V.C., and G. Waring. 1980. The assessment and management of the Georges Bank herring fishery. Rapp. P.-v. Reunion Cons. int. Explor. Mer. 177:72-111.

Clark, S.H. (Ed). 1998. Status of the fishery resources off the Northeastern United States for 1998. NOAA Technical memorandum NMFS-NE-115. 149pp. 1998. NOAA Technical memorandum NMFS-NE-115. 149pp.

Hennemuth, R.C., and S. Rockwell. 1987. History of fisheries conservation and management. Georges Bank, R.H. Backus and D.W. Borne, editors. MIT Press, Cambridge, Massachusetts and London England. PP 430-446.

Lough, R.G., G.R. Bolz, M.Pennington, and M.D. Grosslein. 1985. Larval abundance and mortality of Atlantic herring (Clupea harengus L.) Spawned in the Georges Bank and Nantucket Shoals areas, 1971-78 seasons, in relation to spawning stock size. Journal of Northwest Atlantic Fishery Science. 6:21-35.

Northeast Fisheries Science Center. 1998. Atlantic herring: Report of the 27th Northeast regional stock assessment workshop (27th SAW). Stock Assessment Review Committee (SARC) Consensus Summary of Assessments. Northeast Fisheries Science Center. 360pp.

Northeast Fisheries Science Center. 1999. Fisherman's Report: Bottom Trawl Survey. National Marine Fisheries Service. Woods Hole Laboratory. March 1 - April 22, 1999. 31pp.

Stevensen, D.K. 1989. Spawning locations and times for Atlantic herring on the Maine Coast. Maine Department of Marine Resources Research Reference Document 89/5.

Stephenson, R.L., and I. Kornfield. 1990. Reappearance of spawning Atlantic herring (Clupea harengus harengus) on Georges Bank: population resurgence not recolonization. Canadian Journal of Fisheries and Aquatic Sciences. 47:1060-1064.

Zinkevich, V.N. 1967. Observations on the distribution of herring, Clupea harengus L., on Georges Bank and in adjacent waters in 1962-1965. ICNAF Research Bulletin. 4:101-115.